EVA Task and 3D Suit Pose Recognition from Videos

Executive Summary

Extravehicular Activity (EVA) has been known to involve potential risks of biomechanical stresses and injuries to crewmembers. Gathering of EVA motion patterns is necessary for risk analysis and mitigation. However, many existing techniques, such as motion capture systems, are not only cost-prohibitive but are impractical for retrospective analysis of past missions. In this work, a software tool was developed, which can estimate the 3D poses of a spacesuit from photographs or videos, without using special sensors or equipment. The tool is based on the state-of-the-art artificial intelligence and machine learning (AI/ML) system, which was trained by studying and capturing motion patterns of past and current spacesuit test data. The AI/ML tool was further enhanced using synthetically generated data, in which the suit postures, backgrounds, camera angles and illumination conditions were parametrically adjusted and rendered for training. The tool, incorporated the methodologies of Convolutional Neural Network (CNN), was trained, and tested in the cloud computing environment. The trained model was then applied on new imagery and video to extract estimated joint positions and suit outlines. The joint positions were further processed to capture activity (“digging”), pose labels (“bending”), and other useful downstream information. The model performance on new imagery and video was successfully assessed for accuracy and reliability. This AI/ML based posture recognition tool thus allows for the quantification of injury risk and task performance characterization for both current and past missions and training, which can immensely help to improve EVA task and suit design.